Chapter 5: Managing the Data

Data management limitations significantly affect the SSN capability to detect and track orbital debris. This in turn affects our ability to accurately characterize the debris population and to develop options to minimize debris propagation and to survive the debris environment.

I. Current Data Management Status

The process of keeping track of large objects in space, conducted by DOD, involves three steps: (1) collecting sensor observations, (2) correlating these observations to known objects, and (3) updating the object database with the new observations. The database must be updated daily, for all but GEO objects, to keep an accurate and usable catalog of space objects. The correlation process is crucial to the overall process and in many instances requires analyst intervention.

II. Opportunities for Improvement and Further Research

A. Databases

The Space Defense Operations Center, block 4 (SPADOC 4) is now operational. The addition of SPADOC 4 increases the capability for database management and database size. New computer hardware will allow for cataloging of 30,000 on-orbit objects—this is about three times the prior capability. In addition to enhanced database capability, the system provides enhanced sensor tasking and orbit propagation capabilities.

B. Modeling

There is a need to characterize the orbital debris environment, even when observations are not practical, such as when the size or altitude of objects makes measurements difficult. Modeling, then, is required to combine existing measurements and theory in such a way that predictions can be made. Several types of models are required to make these predictions:

(1) A model to describe future launches, the amount of debris resulting from these launches, and the frequency of accidental or intentional explosions in orbit (traffic model).
(2) A model to describe the number of fragments, fragment size, and velocity distribution of ejected fragments resulting from a satellite explosion or collision (breakup models).
(3) A model which will make long-term predictions of how debris orbits will change with time (propagation model).
(4) A model which predicts collision probabilities for spacecraft (flux or risk model).
(5) A model which predicts hazards in the near term from a breakup event.
(6) Development of models for breakup and dispersion of reentering objects.

Many of these models exist; however, they require elaboration and refinement.

C. Validation and Analysis

Models of an environment or a process must be tested empirically for accuracy and predictability. If the output of the models does not match the real world, or if the predictions produced by the models are not repeatable each time the model is run, the model is not valid and it must be reformulated. To validate the models, test scenarios must be developed to allow empirical data to be compared to model results. The tests normally involve collecting a limited set of data, where possible, and comparing the data set to the model results, having run the model under the same conditions as the collected data. These tests not only validate models but also serve to refine the models for increased accuracy. This validation method certainly applies to debris models. Since several organizations have ongoing debris modeling efforts, models and model predictions are archived for later use as test data for future debris modeling efforts. NASA and DOD both jointly share these tasks.